



Project Abstract

Modeling the Synergistic Effects of Social and Ecological Change in the 19th-Century North American Cod Fishery

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Today, rapid resource depletion and deterioration of the natural environment threaten many human societies. Communities dependent on open access to natural resources are vanishing as resources become scarce. They take with them intimate knowledge about the natural world gleaned through generations of experience. Nowhere is this more evident than in commercial fisheries. Declining fish stocks, ineffective management policies, and increased marginalization of fishermen worldwide imperil coastal fishing communities, marine ecosystems and critical food resources. Understanding long-term interactions between fisheries and the marine ecosystem is essential to saving them, but few baseline studies exist describing human engagement with marine ecosystems in the past.

Recent studies have shown that overfishing is not new, but existed long ago. In the 19th-century, halibut stock in the northwest Atlantic collapsed, forcing Gloucester fishermen to venture as far as Iceland in search of the valuable fish. In the 1860s and 1870s, anadromous fish runs declined precipitously after weirs and pound nets multiplied. Public outcry led to the creation of state fish commissions and the US Fish Commission, a forerunner of NOAA, was formed in 1871. Even 150 years ago, New England's cod fishery experienced regional downturns due to declining catch. This federally subsidized, but unrestricted fishery offers an excellent model for examining social and environmental variables surrounding resource depletion, and how fishermen responded to them.

Archival records of New England cod fishing vessels between 1852 and 1866 present a data set suitable for modeling human behavior in the hook and line fishery, and investigating the synergy between social and ecological change. Logs can report daily catch, vessel location, depth of water, and the condition of the sea floor, as well as family affinities among the crew and communications with vessels fishing nearby. Fishing agreements list vessel size, homeport, crew names and residences and total catch weight after drying. The combination of daily catch statistics, observations at sea and geographic location with social, cultural and demographic data discloses communitarian knowledge systems, information networks and decision-making processes operating within ecological and social contexts. This interdisciplinary project, undertaken by environmental historians and marine scientists, correlates ecological change on cod fishing banks in the mid 19th-century with choices made by New England fishermen plying their trade with hook-and-line from wooden boats. Stained with saltwater and fish oil, written in smudged ink or faded pencil, occasionally embellished with drawings of fast schooners under full sail, the logs are more than sources of data (Fig. 1). Entries ranging from cryptic and illegible to clear and poetic reveal the stories of men steeped in the natural language of the marine environment.

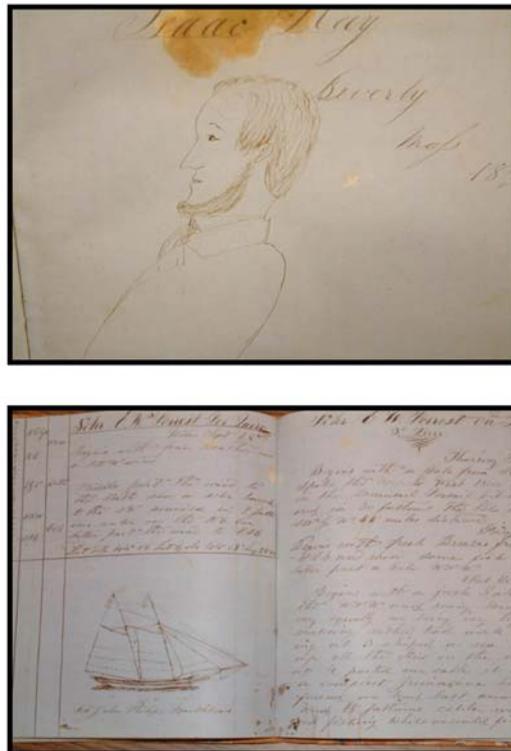


Figure 1. Log book illustrations from the cod fishery, 1852-1866, courtesy of the National Archives and Records Administration, Waltham, MA.

Data from archival manuscripts are being extracted, entered into databases, and analyzed historically to identify affinity groups, fishing patterns, knowledge systems and trends in human demography. Work underway on the inshore Gulf of Maine fishery complements earlier work on the Scotian Shelf. Over 36000 daily records from 300 fishing logs of vessels sailing from the Frenchman's Bay, Maine, Customs District between 1860 and 1865 have been entered into preliminary databases for quality control, and transfer to an online MYSQL database is underway; 2500 fishermen have been entered into a separate database for identification in census, probate, and town records, and other historical sources. Global Information Systems (GIS) software enables tracking changes in the distribution of catch, fishing patterns, and human demographics over time. The geographic distribution of fishing vessels will be correlated with homeport, familial and social affinities, and biological indicators for cod stock generated by fisheries stock assessment models. Discrete choice modeling identifies and ranks variables that influence behavior and signal changes such as adopting new technologies, altering fishing strategies and accepting greater risk in a dangerous business.

The logs reveal fishing patterns very different from the Beverly, Massachusetts, cod fleet, the focus of our previous study. While two thirds of Beverly vessels fished the Scotian Shelf and vessel size correlated to choice of fishing ground, 91% of Frenchman's Bay vessels fished



inshore grounds regardless of size. For instance, in 1861 the 120 ton ORATOR of Surry in Blue Hill Bay fished in roughly the same region as the 8 ton UNION of Ellsworth, up the Union River at the head of Blue Hill Bay. Small boats fished hard. The UNION caught four times more cod per ton-of-vessel than the ORATOR, a general trend suggesting that a reverse economy of scale was in effect.

Logs identify fishing banks by name. Landmarks and compass bearings, not navigational coordinates, determine course. Names are often local and idiosyncratic. The Frenchman's Bay inshore fleet fished a well-defined zone from Isle au Haut in Penobscot Bay to Grand Manan (Fig. 2). Fishing banks (Goode 1887, Rich 1929) were mapped in Geographic Information Systems (GIS) and coordinate with the MYSQL database. Aggregation of catch per day per bank is ongoing as further data is entered.

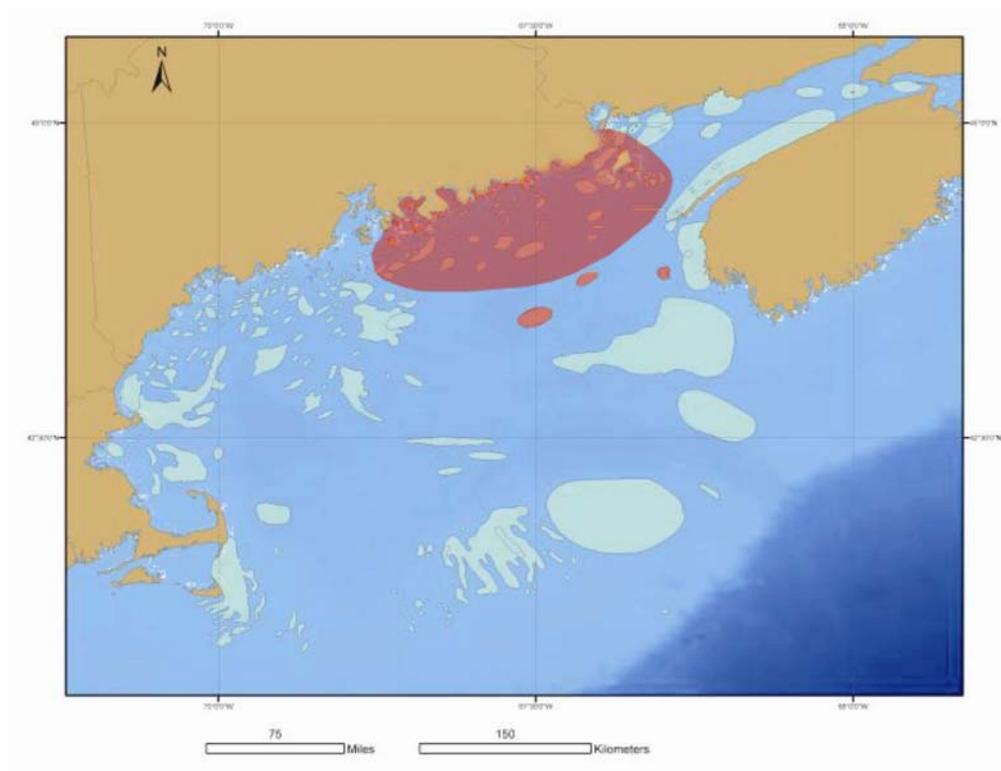


Figure 2. GIS map of the Gulf of Maine showing fishing grounds identified by Walter Rich of the Bureau of Fisheries in 1929. The region where 91% of the vessels from Frenchman's Bay, Maine, fished for cod from 1860 to 1865 is identified in red.

Vessel size influenced fishing patterns within the Gulf of Maine. Small boats fished in bays and tidal rivers and unloaded catch every few days to be dried by a shoreman. Larger schooners fished east to west along the coast and farther out to sea. Eighty percent of Frenchman's Bay vessels under 40 tons appear to have been operated by two or more members of the same family. Seventeen vessels were captained by men under 21, one by a 15 year old boy. Alvah Doliver, a



girl of 13, fished with her father, and evidence suggests that boys as young as 6 were on board some vessels.

Frenchman's Bay skippers used tub trawls to land the same amount of fish quicker, not to land more fish in the same amount of time, as was the case in Beverly. Nevertheless, preliminary figures for overall catch show that, in 1861, 81 small schooners caught 5180 mt of cod between Isle au Haut and Grand Manan, an area almost devoid of cod today. This is nearly as much as the entire Gulf of Maine yielded in 1999 and 2000 combined.

The biomass estimate for Scotian Shelf cod in 1852 has already influenced scientific and public notions of past species abundance. Biological indicators such as this dispel the myth of low productivity even as they raise the possibility of a regime shift towards lower trophic levels in the marine ecosystem. Profound shifts in abundance of keystone species like cod can serve as indicators of ecosystem health. They raise the bar for rebuilding productivity by orders of magnitude. Nineteenth-century records of cod landings in the Gulf of Maine promise further evidence of startling abundance distributed throughout shallow bays, up tidal rivers, and on fishing grounds covering just a few acres. Frenchman's Bay vessels fishing at anchor provide ecosystem data in much finer detail than modern trawl surveys. Evidence of bait fishing in cod logs shows how the demersal fisheries affected other species populations in the inshore ecosystem, and indicates productivity on lower trophic levels.

By identifying modes of traditional behavior among mid 19th-century New England cod fishermen, analyzing the factors influencing them and charting trends in their behavior, this project contributes a behavioral baseline for an important modern fishery currently in freefall. Establishing a historic range of responses to ecological and economic crises may suggest more options in today's highly polarized management debates. Acknowledging 19th-century fishermen as accurate observers of the environment encourages a dialog between contemporary scientists and fishers on the state of the marine ecosystem. Better management policy may eventually result from such a dialog. Our interdisciplinary analyses contribute to an understanding of humans as architects of the natural world, and of nature as an agent of social change even as they expand the potential for interdisciplinary education in the sciences and humanities.

The Gulf of Maine Cod Project (GMCP) at the University of New Hampshire trains graduate and undergraduate students in all aspects of historical ecology as they work with original documents, modern statistical modeling and GIS. As part of the Alfred P. Sloan Foundation's History of Marine Animal Populations (HMAP) program, UNH partners with national and international colleges and universities. Besides participating in and hosting workshops and conferences sponsored by HMAP, a PhD candidate from the University of Southern Denmark studied historical and statistical analysis at UNH in 2004. Fulbright scholars from the European University in St. Petersburg, Russia will be in residence in 2005 and 2006 collaborating on the analyses of historic North Atlantic cod and Atlantic salmon fisheries.

GMCP staff regularly participate in regional conferences and workshops, and give public lectures. We have advised local museums, and local, National and Canadian Public Television



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on aspects of our work. Recently, Stellwagen Bank National Marine Sanctuary joined with us to begin reconstructing the changing ecology of the sanctuary region from historical records. Its detailed focus on all species in one small part of the Gulf of Maine over hundreds of years compliments the Cod Project's focus on one fishery region-wide in the mid 19th century. Sanctuary officials are interested in the potential of historical ecology to engage public imagination. Our project is serving as a pilot for other National Marine Sanctuaries interested in a historical component. Records of fishermen from the 1860s show how closely these men were connected to their ocean environment. The data is inextricable from their narratives and stories. These histories hold the promise of connecting science to people, and making the ocean a meaningful human space.